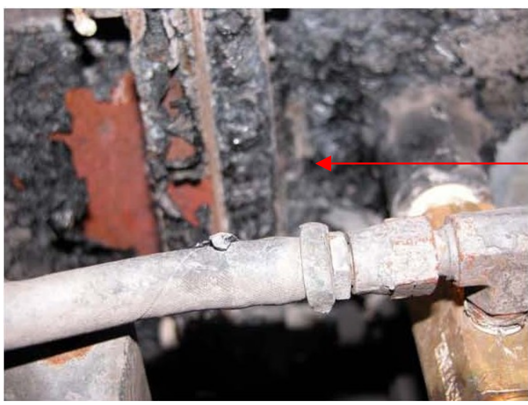
NSW DEPARTMENT OF
PRIMARY INDUSTRIES

SAFETY ALERT

Danger of Methane Explosion from Diesel Engine Systems

INCIDENT

A diesel engine system (DES) was inadvertently driven into a methane rich environment (8% recorded). The diesel engine revved high, was uncontrollable and the operator was unable to shut the diesel engine down. An exhaust manifold cooling system hose failed. This resulted in the exhaust manifold being severely heat affected to such an extent that the epoxy paint turned to ash.



Heat affected paint

This all occurred in an explosive rich atmosphere for a substantial period of time. This event had a significant potential to initiate a major gas explosion.

CIRCUMSTANCES

A man transport vehicle was being driven by a deputy to transport two contractors into the mine's longwall return headings. The vehicle was to be driven through two sets of double brattice doors. The deputy checked for methane, found 2.5% and diluted it to 0.7% before proceeding to drive inbye towards the longwall.

As the deputy was driving inbye, his methane detector alarmed, indicating a methane concentration greater than 1%. At the same time the diesel engine started revving high. The deputy then attempted to stop the diesel engine system without success. The deputy then chose to drive towards fresh air while trying to shut the diesel engine down. The gas levels on two methane detectors indicated greater than 5% methane. Smoke was noticed coming from under the vehicle's bonnet.

Mine Safety Report No: SA05-08
File No: 05/1869
Comet ID: 3175 2042 7001
Prepared by: Peter Sunol
Phone: 0418 638023
Date Created: 10/5/2005

When the vehicle was in what the deputy believed to be fresh air, he cut hoses in the engine compartment, carried out a coolant loss and low water shutdown test, drained the air receiver and drained the fuel tank in an attempt to stop the engine system.

At the same time the fuel tank was being drained, the double doors were closed (returning ventilation to normal) and the engine stopped shortly thereafter.

INVESTIGATION

The investigation and further simulation testing on the vehicle has confirmed:

1. The diesel engine system was running on methane only with the diesel fuel shut off. It appears the contributing factors for this to occur are:
    - A methane rich atmosphere of greater than 5% is required.
    - The exhaust gas temperature needs to be hot. Sufficient temperature may be reached when operating under high load.
    - When running on methane the exhaust temperature rises quickly and the engine speed increases significantly (150% in simulation).
    - The engine may stall if a mixture of greater than 5% is introduced and the exhaust temperature is not hot enough to ignite the methane.
2. The diesel engine system stopped only because the environment methane concentration reduced.
3. The 8% methane concentration was recorded in the same heading the vehicle was operating in.
4. The heading was an intake ventilated by a surface borehole. It was contaminated by an inrush of methane from the longwall goaf due to a damaged seal and change in ventilation.
5. Portable Methane detection on the vehicle was too slow to alarm the operator to shut down the diesel engine before it was running on methane only.
6. The engine system is an explosion protected engine system designed to AS 3584 which applies to diesel engines systems operating in an atmosphere containing up to 1% methane.
7. The explosion protected properties of the diesel engine system prevented a methane explosion. High levels of methane were detected in the engine exhaust during simulation.
8. The engine system appeared to be clean and there was no evidence of oils, grease or coal dust on the hot exhaust manifold.
9. The engine lost cooling water due to a hose failure from the exhaust manifold.

    Note: The engine cooling system may not be adequate to prevent the diesel engine system from overheating when running on methane.
10. A 5kg Carbon Dioxide fire extinguisher was used to stop the diesel engine system when running on maximum revs on diesel fuel as a simulation for shutting down an engine when running on methane.

RECOMMENDATIONS

All underground coal mines should:

1. Carry out a risk assessment to identify the risk of methane inrushes prior to the use of a diesel engine system in significant risk areas of the mine such as all return headings and adjacent to longwall goaf areas.

Note: The risk assessment should include consideration of the following:- human error, ventilation management, barometric changes, seal failures, leaking seals, goal falls, or the like, the events of this incident and emergency procedures.

2. As an interim measure until proper engineering controls are implemented, develop a system to manually shutdown all diesel engine systems in an emergency. This should be done in consultation with the equipment manufacturer and mine employees. Suitable systems may be use of an inert gas fire extinguisher or blocking of the air intake.

   The emergency manual shutdown system, should be:

   - installed immediately on all diesel engine systems operating in any significant methane risk area identified in the risk assessment.
   - demonstrated to all operators
   - able to stop the diesel engine system when running on diesel fuel only, at maximum engine speed and without shutting down the diesel fuel supply.

3. Install an approved engineered permanent emergency shutdown system on all diesel engine systems as soon as practicable.
4. Implement controls to ensure diesel engine systems are not exposed to methane concentrations greater than 1% and the diesel engine is shut down immediately following an alarm detection of 1%. This incident highlights the speed with which a methane inrush can occur.
5. Audit and monitor the integrity of the mines diesel fleet;
   - against AS 3584.2:2004, identify the differences, assess the risks and implement appropriate controls
   - to ensure that explosion protection properties are maintained in accordance with AS 3584.2:2004 & AS 3584.3:2005, the approval conditions and the manufacturer's recommendation.

   Note: All safety shutdown controls should be regularly tested to ensure effective operation. Where there are dual safety devices, both devices must be tested independently.

6. Audit and monitor the mines diesel fleet to ensure there is no excess or spillage of combustible materials in the engine compartment. It is suggested that the cleanliness of the engine may have been one of the saving factors in preventing a methane explosion.
7. Consult with all operators of diesel engine system the regarding the content of this safety alert and highlighting the importance of the explosion protection properties of the diesel engine system and actions in an emergency.
8. Train and establish that all operators are competent in the use of the emergency shutdown systems and the manual fuel shut off valve.

Signed

Rob Regan
CHIEF INSPECTOR OF COAL MINES
DIRECTOR MINE SAFETY OPERATIONS BRANCH
NSW DEPARTMENT OF PRIMARY INDUSTRIES

View more safety alerts at www.minerals.nsw.gov.au. If you would like to receive safety alerts by email, send your details to safetyalert@minerals.nsw.gov.au .

Mine Safety Report No: SA05-08
File No: 05/1869
Comet ID: 3175 2042 7001
Prepared by: Peter Sunol
Phone: 0418 638023
Date Created: 10/5/2005